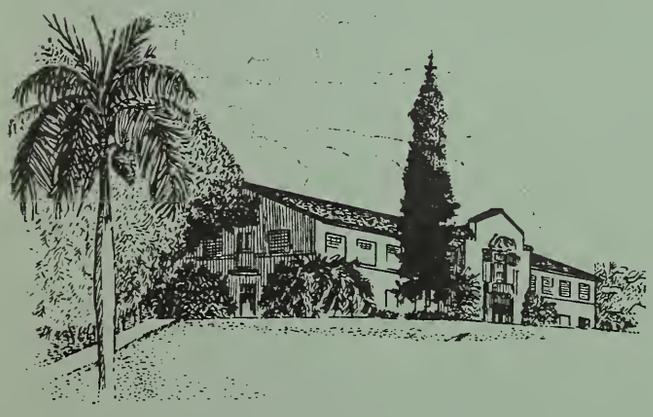
FOREST SERVICE RESEARCH PAPER ITF-14

SEPTEMBER 1972

TREE SPECIES FOR PLANTATIONS IN THE GRANITIC UPLANDS OF PUERTO RICO

BY T. F. GEARY AND C. B. BRISCOE



INSTITUTE OF TROPICAL FORESTRY
RIO PIEDRAS, PUERTO RICO

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

SUMMARY

Thirty-two tree species were tested for adaptability in Puerto Rico's humid, granitic uplands, a region of sandy, well drained, erosive soils. Based on adaptability and potential wood uses the following species are recommended for timber plantations: Honduras pine for most landowners; mahoe for those willing to speculate on development of a demand for this cabinet wood; kadam for those with special interest in this lightweight, general utility wood, and those with severe weed problems; and eucalyptus or casuarina for owners interested only in post and pole crops.

RESUMEN

Treinta y dos especies de árboles fueron probadas para su adaptabilidad a las alturas graníticas y húmedas de Puerto Rico, una región de suelos erosivos, bien drenados, y arenosos. Basado en la adaptabilidad y usos potenciales de la madera, las siguientes especies son recomendadas para plantaciones maderables: pino hondureño para la mayoría de los dueños de terrenos; mahoe para aquellos que estén dispuestos a especular en el desarrollo de una demanda por esta madera para gabinetes; kadam para aquellos con interés especial en esta madera liviana y de utilidad general, y para aquellos con problemas graves de yerbajos; y eucalipto o casuarina para los dueños de terreno que solamente estén interesados en la producción de postes para verjas y para construcción.

TREE SPECIES FOR PLANTATIONS IN THE GRANITIC UPLANDS OF PUERTO RICO

by

T. F. Geary and C. B. Briscoe[1/]

Institute of Tropical Forestry, Río Piedras, Puerto Rico[2/]

INTRODUCTION

There are 40,000 hectares of granitic uplands in southeastern Puerto Rico and 20,000 hectares in the western center of the island (1). Soils are sandy, mostly well-drained, and easily eroded; elevation ranges from sea level to 750 m; rainfall ranges from 1650 to 2500 mm. These areas lie within subtropical moist and wet ecological life zones (5). Subsistence farming, once common, has practically disappeared; timber crops could be a renewed use of this land.

METHODS

From 1959 through 1961 the Institute of Tropical Forestry planted many timber species in adaptability tests on nine sites representing much of the soil (table 1) and climatic conditions of these uplands. Species were compared by single tree plots arranged in randomized complete blocks (2, 3). Three to several species, always including Honduras pine (*Pinus caribaea* var. *hondurensis* Barr. & Golf.), were planted to a block (Figure 1). Three to eleven blocks, usually

Figure 1.– Portion of a nine-year-old block with single-tree plots in a species trial on Pandura sandy loam.

1/ The junior author is currently assigned to the USDA Forest Service, Southern Forest Experiment Station.

2/ In cooperation with the University of Puerto Rico.

each with a different species mix, were planted to a site. There were a total of 67 blocks in the study. Seedlings were raised in pots and planted at 2.5 meter square spacing.

Honduras pine was used as the standard against which all other species were compared, because it occurred in all blocks and exhibited good adaptability. Each of the other species were compared only with the Honduras pine within blocks in common. Rapid early height growth was a critical factor in evaluating species, because the cost of weeding is intolerable for initially slow-growing species, even for very valuable cabinet woods. A minimum requirement was 1.8 meters height growth in the first two years. At all ages, height was given more weight in evaluation than diameter, for the latter is more influenced by stand density, which was not controlled. Height comparisons after age five were not made for most species; by then faster-growing trees had begun to suppress the slower.

Potential uses of the wood were as important as growth in evaluation. In fact, the two criteria are interrelated – the more valuable the wood per unit volume, the slower the growth rate that can be tolerated after the establishment period. Survival was considered, but with lesser weight than growth and wood uses, because it is difficult to separate initial losses due to poor adaptability from poor establishment techniques. Stem form, attack by insect and diseases, and reliability – the variability from block to block – were additional factors.

Important in evaluation was information about the species from other studies in Puerto Rico and elsewhere in the tropics, and general rules about responses of trees in climatic and latitudinal zones different from their native habitat. This helped predict adaptability and offset the restricted range of seed sources used and the few plantings of some species, thereby adding confidence in interpreting results.

RESULTS AND DISCUSSION

Honduras pine grew well on all sites. However, there was a considerable growth difference between the two granitic upland regions, the better being the west central (table 2), where rainfall is higher and soils deeper. Growth was not correlated with soil type, although growth was slowest (10.5 meters mean height in ten years) on the very shallow Teja soil, which was also, however, the site receiving the least rainfall.

Honduras pine survived and grew better than any other conifer (table 3). *Cupressus lusitanica* proved susceptible to windthrow. A table of data for two years after planting would show approximately the same height ratios as table 3.

In a separate study insular and continental ecotypes of *Pinus merkusii* Jungh et de Vriese were found to be unsuitable (6). Therefore, the only conifer that can be recommended presently for timber plantations on the sandy upland soils of Puerto Rico is Honduras pine. Testing of a wider range of seed sources of *P. oocarpa* var. *ochoterenai* and *P. caribaea* var. *caribaea* is warranted, as well as *P. caribaea* var. *bahamensis* Barr. & Golf. and *P. kesiya* Royle ex Gordon, which have not been tested yet.

Several broadleaf species were as adapted as Honduras pine; those recommended for planting are listed with additional growth data in table 4. Certain other species were considered but rejected: *Cecropia peltata* -unreliable, wood of doubtful commercial value; *Khaya* species - initial growth too slow, bark cankers, unreliable, good cabinet wood but markets uncertain; *Maesopsis eminii* - unreliable, mediocre wood quality, but worth testing further in pilot plantations because of its rapid growth on some sites; *Tectona grandis* (teak) - growth too slow to pay establishment costs, despite high value of wood.

CHOICE OF SPECIES FOR PLANTATIONS

Most landowners should plant Honduras pine (Figure 2). It is easy to grow, reliable, and offers a wide range of uses, including posts, poles, lumber, plywood, particleboard and pulp. It is attractive, especially during the dry season when much vegetation is brown or leafless. Unfortunately, it is also more flammable than most tree species in Puerto Rico, so large plots should not be planted close to buildings.

Figure 2.– Eleven-year-old, thinned plantation of Honduras pine on Pandura sandy loam.

Landowners willing to speculate may plant mahoe *(Hibiscus elatus)* or kadam *(Anthocephalus chinesis).* Mahoe (Figure 3), a cabinet wood native to Jamaica and much used there, is as reliable silviculturally as pine, but a market for the wood grown in Puerto Rico does not now exist. Kadam produces a lightweight, general utility wood with as many uses as pine, but it is less reliable; the coefficients of variation for survival and growth were double that of pine on the same sites. Also, thrips have caused serious leaf damage. Kadam does have an advantage over pine on sites where it grows well; its broad crown quickly suppresses weeds. Fortunately, there are indications that kadam grows well on sites where weed growth is luxuriant, the type of site on which it is expensive to weed pine. Therefore, pine might be planted on degraded pasture and crop land, and kadam on sites with lush herbaceous growth, and on woodland to be converted to a plantation, where vines are often a serious weed problem (4).

If a landowner is only interested in producing posts or poles, he should plant one of the eucalypts (Figure 4) or casuarina. These products can be produced on short rotations, accept preservative treatment well, and, with the eucalypts, subsequent crops can be obtained from coppice.

ACKNOWLEDGEMENTS

We thank the following cooperators for providing the land for this study: Mr. Santana Delgado Díaz, Yabucoa; Mr. Adrián Medina, Humacao; Mr. Rafael Meléndez Ramos, Yabucoa; Mr. Antonio Pérez Roig, Utuado; Mr. Juan Reyes Delgado, Jayuya; Antonio Roig Sucrs. Inc., Humacao; Mr. Bartolomé Rullán Rivera, Utuado; Mr. Carmelo Silva, San Lorenzo; and Mr. Ramón Toro Pérez, Utuado.

Figure 3.– Eleven-year-old mahoe trees on Lirios silty clay loam.

Figure 4.– Five-year-old eucalyptus crop of posts and poles.

Table 1.--Soils of the test sites.

Soil series[1/]	Classification[2/]	Upland region			
		Southeast		West Central	
		Sites	Blocks	Sites	Blocks
		Number of tests			
Lirios silty clay loam	Typic Tropudult	2	18	1	9
Pandura sandy clay loam	Typic Eutropept	2	9	3	28
Teja gravelly sandy loam	Lithic Troporthent	1	3	0	0

1/ Soil series descriptions are available from the USDA Soil Conservation Service, Fort Worth, Texas.

2/ By the 7th Approximation of a Comprehensive System of Soil Classification of the International Society of Soil Science.

Table 2.--Growth and survival of Honduras pine in the granitic uplands of Puerto Rico.

Variable	Age	Region	
		Southeast	West Central
Survival (%)	5 years	66	81
Height (meters)	2 years	2.0	2.0
	5 years[1/]	7.1	8.2
	10 years[1/]	12.3	14.8
DBH (cm)	10 years	18	20

1/ Difference between regions statistically significant.

Table 3.--Survival and growth five years after planting of 31 introduced species in comparison to Honduras pine.

	Number test plantings			
	Sites	Blocks	% Survival[1/]	Height[1/]
Anthocephalus chinensis Rich	7	16	93	101
**Araucaria angustifolia* (Bert.) O. Kuntze	2	2	37	26
**Callitris hugellii* (Carr.) Franco	1	2	56	11
Casuarina equisetifolia L.	3	3	91	132
Cecropia peltata L.	5	5	31	108
Cordia alliodora (Ruiz & Pav.) Oken	3	7	38	26
**Cupressus lusitanica* Mill.	2	2	78	56
Cybistax donnell-smithii (Rose) Seibert	9	18	25	35
Enterolobium cyclocarpum (Jacq.) Gris.	3	3	108	78
Eucalyptus x patentinervis R. T. Bak.	5	5	59	89
Eucalyptus tereticornis Sm.	2	2	133	136
Hibiscus elatus Sw.	5	9	72	99
Khaya nyasica Stapf.	3	3	105	74
Khaya senegalensis (Desr.) A. Juss.	4	4	107	67
Maesopsis eminii Engl.	5	5	20	122
**Pinus caribaea v. caribaea* Morelet	7	23	76	80
**Pinus douglasiana* Martínez	6	6	48	54
**Pinus elliottii v. elliottii* Engelm.	4	4	66	25
**Pinus massoniana* Lamb.	7	8	58	38
**Pinus michoacana* Martínez	5	6	25	33
**Pinus montezumea* Lamb.	2	2	36	37
**Pinus occidentalis* Sw.	7	12	21	37
**Pinus oocarpa* Schiede (ex Guatemala)[2/]	8	15	65	86
**Pinus oocarpa* Schiede (ex Mexico)[3/]	8	10	55	55
**Pinus pseudostrobus* Lindl.	6	6	70	50
**Pinus taeda* L.	5	5	54	34
Pithecellobium saman (Jacq.) Benth.	2	2	0	--
Plantanus occidentalis L.	5	5	2	--
Spathodea campanulata Beauv.	6	6	116	60
**Taxodium mucronatum* Tenore	2	4	109	30
Tectona grandis L. f.	4	4	80	51

[1/] As a percentage of that of Honduras pine in blocks in common.

[2/] Probably variety *ochoterenai*.

[3/] Probably variety *typica*.

*Conifers; species unmarked are broadleafs.

Table 4.--Broadleaf species recommended for planting in the granitic uplands, and their growth in comparison to Honduras pine.

	Height[1/]		DBH[1/]
	2 years	10 years	10 years
Anthocephalus chinensis	147	89	89
Casuarina equisetifolia	167	130	100
Eucalyptus x patentinervis[2/]	110	100	86
Eucalyptus robusta[3/]	---	---	---
Eucalyptus tereticornis	235	122	81
Hibiscus elatus	101	100	107

1/ As a percentage of that of Honduras pine in blocks in common.

2/ Synonym *E. kirtoniana* F. Muell, a hybrid of *E. robusta* and *E. tereticornis*.

3/ *E. robusta* Sm. not included in study plots, but adaptability already proven.

LITERATURE CITED

(1) Briggs, R. P. and Akers, J. P.
1965. Hydrogeological map of Puerto Rico and adjacent islands. Hydrologic Investigations Atlas HA-197. U. S. Geological Survey, Washington, D. C.

(2) Briscoe, C. B.
1961. Statistically valid planting trials. Proceedings Second World Eucalyptus Conference, p. 525-531.

(3) _____
1965. Initial field testing for forest tree improvement. Journal Oxford University Forestry Society, Series 5, No. 13: 16-21.

(4) Geary, T. F. and Zambrana, J. A.
1972. Must Honduras pine be weeded frequently in Puerto Rico? U.S.D.A. Forest Service Research Paper ITF-16.

(5) Holdridge, L. R.
1967. Life zone ecology. Tropical Science Center, San José, Costa Rica. 206 p.

(6) Whitmore, J. L.
1972. *Pinus merkusii* unsuitable for plantations in Puerto Rico. Turrialba. (In press).

Geary, T. F. and Briscoe, C. B.

1972. Tree species for plantations in the granitic uplands of Puerto Rico. USDA Forest Service Reseach Paper ITF-14.

Thirty-two tree species were tested for adaptability in Puerto Rico's humid, granitic uplands, a region of sandy, well drained, erosive soils. Based on adaptability and potential wood uses the following species are recommended for timber plantations: Honduras pine for most landowners; mahoe for those willing to speculate on development of a demand for this cabinet wood; kadam for those with special interest in this lightweight, general utility wood, and those with severe weed problems; and eucalyptus or casuarina for owners interested only in post and pole crops.

O.D.C. 232.11 (729.5)

Geary, T. F. and Briscoe, C. B.

1972. Tree species for plantations in the granitic uplands of Puerto Rico. USDA Forest Service Reseach Paper ITF-14.

Thirty-two tree species were tested for adaptability in Puerto Rico's humid, granitic uplands, a region of sandy, well drained, erosive soils. Based on adaptability and potential wood uses the following species are recommended for timber plantations: Honduras pine for most landowners; mahoe for those willing to speculate on development of a demand for this cabinet wood; kadam for those with special interest in this lightweight, general utility wood, and those with severe weed problems; and eucalyptus or casuarina for owners interested only in post and pole crops.

O.D.C. 232.11 (729.5)

Geary, T. F. and Briscoe, C. B.

1972. Tree species for plantations in the granitic uplands of Puerto Rico. USDA Forest Service Reseach Paper ITF-14.

Thirty-two tree species were tested for adaptability in Puerto Rico's humid, granitic uplands, a region of sandy, well drained, erosive soils. Based on adaptability and potential wood uses the following species are recommended for timber plantations: Honduras pine for most landowners; mahoe for those willing to speculate on development of a demand for this cabinet wood; kadam for those with special interest in this lightweight, general utility wood, and those with severe weed problems; and eucalyptus or casuarina for owners interested only in post and pole crops.

O.D.C. 232.11 (729.5)

(1) Briggs,]

(2) Briscoe,

(3) ———

(4) Geary, T

(5) Holdrid

(6) Whitmo